Notebook Series -- Notebooks by Edison
Notebook, N-19-10-06

This notebook is a continuation of N-19-09-09. It was used by Edison during October-November 1919, primarily for electroplating experiments performed with various numbered solutions. Many of the entries refer to nickel and copper plating of flake for use in storage batteries. Also included are notes on disc record manufacture and the electroplating of master record matrices. In addition, there are entries describing experiments on the regeneration of flake from old battery cells, as well as a few experiments with primary batteries. One entry indicates the amount paid by the Ford Motor Co. for two different makes of automobile starter battery. As with preceding books in this series, this notebook offers evidence of the convergence of Edison's interests in battery and disc record manufacture resulting from the electrolysis involved at various stages of production. The notes indicate that John McMullen and Frederick P. Ott assisted Edison. Inserted into the book is a communication from E. E. Dougherty to Edison regarding disc molds. The front cover is labeled "No 5 General Book October 6th 1919." The pages are unnumbered. Approximately 80 pages have been used.

1 Liter 20% NaOH.
dissolves 170 grms of metallic
Zinc in our battery
under practical conditions
(not theoretical) —

Oct 6 1919

432 = 200 cc Nickel Chloride
150 cc Water 15 cc Copper
acetate Brown Ni deposit
Copper ditto NG
200 ma Ni 25 ma on Copper

Selenic acid neutralized by
Soda deposits on Copper anode
100 ma — Selenide Copper but
it dont show anything on
Nickel anode — in fact
Ni Cathode shows a darkening
while the neutral NaSelenate
didnt attack Cu, only
Current at anode dissolved it
yet after 30 secs I taken
off it Colored Cu by
Immersion slightly —

Deshaies Ni is Coated at
Cathode by action of Na
metal on Cu Anode
by direct decomposition

437 - 125 cc Magnesium Sulphate
125 cc Ni SO4
10 cc CuSO4

Started off fair - got 3 or 4 cycles - OK - but 1st cycle bad - but caused strip a little
Stopped Strip with only 4 cc CuSO4

No 2 Best yet 274
next for flake -

439 = 250 cc $NiSO_4$
16 grams Magnesia Sulphate
8 " Nickel Acetate
5 cc $CuSO_4$ —

This starts off well, got 2 layers Nickel on but no Copper found had not put the Copper in now in —
This is a Variation of 437 with ½ the Copper in — + works much better, — 20 Layers — too wavy
Possibly Can improve this by dif stirring + perpendicular

438 — 250 cc $NiSO_4$
16 grms Manganese
5 cc $CuSO_4$
Dont work well — Charong Experiment —

Recp of 438 — Except Cu left out + Cathode made anode to deposit MnO_2 but it Took Ni off the Cathode metal —
Now dilute it ½

(5)

NOTE

164 – with Cu acetate in pretty good + bright for one hour
Says Chlorate of Cobalt 6 gr
doubtful

425 – with Cu acetate
fair for 1/2 hour
Magnesium Butyrate 6 gr

440 250 cc $MnSO_4$
10 grms Manganese Acetate

Dont deposit MnO_2
beet Curls in ok + attack
varnish no.

426 — 5 $CuSO_4$ 5cc acetic

Went cooked for 1 hour

250cc nearly saturated

Cobalt sulphate —

Oct 8 1918 —

For flakes — So far good ones are —

402 — 274 — 125 — 136

301 387 —

All 250cc $MnSO_4$ — 5cc $CuSO_4$

6 Citrate Mag

6 Cerium Sulfate 1c or ous?

6 Benzoate Manganese

Acetate Magnesia

6 Camphorate Soda

Oct 8 1919

Plating Ni first I found black spots — Plating Cu 1st OK + no black spots or Trees —

Stirrer behind Cathode + 1/4" from Anodes

(110)

When I plated Copper 1st Cu OK perfect,

Ni on this dark + very bad shows trees around Edge —

I now repeat this with Cathode which is only cleaned no 8/4 film —

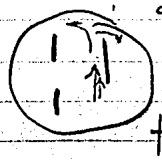
Copper Plated 1st,
Ni 2nd —

~~just~~ not quite so bad but trees bad at Edges + black streaks —

I now add Considerably more of Dimmoddie Dope —
Copper 1st —
Most of the Ni is now very bright but Req fine trees at bottom edge + upward shanks about up 1/2 way top part OK — There are only 1/2 doz specs in main part — No 8/4 —
Trees but small —

I now add Considerable more Dimmiddie dope
1 No 8/4 — looks as if gas adhered + started a spot + plating thru gas there wasn't Enough metal in Sol. —

If this is so then Current of liquid must pass face of liquid so as to detach bubbles + not force liquid against face which tends to force bubbles tighter



this would explain why hand stirring between Electrodes by glass rod gave best results -

All black NG -
Thrown Sol away

We now try

442 = 250 cc NiSO4 Conc
8 grms Acetate Ni

4 cc CuCl2 Kcy - big precip -
Nickel deposit OK Curls up No Copper deposited - probably precipitated all out -

flake -
This is old No 2 - with more Cerium Soy - 250 cc NiSO4
10 grms Cerium Sulphate (Cerious) -
Cu very thin - Ni darkish but no trees has streaks dark but Micro shows OK

Immediate Dope dont work in plating flake from Cu & NiSO4 mixes +

In flake process the Copper in most solutions plates out OK no trees 5 cc of Conc CuSO4 — 12 minutes, in 250 CC Conc NiSO4 — Its the Nickel that trees + is bad.

If the surface is even + smooth tree'ing stops, but if pinhole like record grooves streaks go upward from Edge of grooves also bottom, starts from Varnish where there is a spec on Varnish Undoubtedly adhesion of gas is trouble for streaks + tree'ing — Remove gas + all will be OK

These are Solutions from tests for Malleable Ni plating - ammonia used with 5cc $CuSO_4$ + 5cc Acetic acid to see how Ni plated out 100 ma per sq. in of Cathode

164 — ½ hour fair

272 "

204 "

272 - "

77 1 hour

118 ½ hour

300 ~~[illegible]~~ hour

77 - " 4 grams

77 " 8 "

78 ½ h

387 3/4 hour

303 1/2 H

78 overhour

303 - 1/2 h

210 1/2

118 1/2 H

301 — over H

2 overhour

125 overhour

124 "

Oct 9 1919

At last we have found out how to prevent new flock clay denser from blank from sticking to blank mould Instead of heating 5 min in press & cooling 15 we heat 2 min & cool 8 min — This makes a blank strong enough dont Cook linseed Rosin out so it sticks & at same time makes blank more porous for clinching the varnish

The small Harding Mill Capacity is 400 lbs hour 1st pass then 2nd pass 200 lbs hour —

3 6' ft Mills 16 long will give us 700 lbs blanks 20 hours

Oct 13 1919

Flake plating = With 250 cc
Conc $NiSO_4$ - 5 cc Conc
$CuSO_4$ - 6 grms Acetate
Magnesia Copper plates
out OK & with 10 ma
Cu 200 Ma Ni got 22
perfect cycles

Then made some CP
Conc $NiSO_4$ free of iron
& also CP $CuSO_4$
250 cc $NiSO_4$ - 16 cc
Conc CP $CuSO_4$ -
5 grams acetate of
Nickel instead of
acetate Mg - found
Sol was much higher
Resistance had take off
Leads & put back
1 Edison SB cell -
10 ma no copper plated
out, Added 5 cc more
of $CuSO_4$ - when Copper
plated out

Evidently every solution has its specific peculiarities & will have to determine which sol gives the maximum number of perfect cycles —

There was one change we made however that we didn't have in Mg Acetate Cell —
This is that we plated the whole face, 2" high + over the Edges + we may have had more than 2" area but I think not —

We couldn't get but small amount Cu so added 5cc more $CuSO_4$ total 11cc $CuSO_4$ —
The Copper now plates out OK — 8 Cycles shown under reference that — that no Cross + Edge

Ok but whole Evangelchem has little float Cupola mounts & not hurting separation of flake as there will be no Clinching —
Have it running to 16 Cycles to see if these mounts will get worse or they will Clinch — 16 cycles little domed swellings larger than with scapers but stuck OK
see next page

Note Congo scapes is not blued green by Concentrated acetic acid — 1 cc in 500 cc water of 50-50 H_2SO_4 just blues it but not dead blue —
This is worth to know

We now let it run till 615 pm making 24 cycles.
After 24 cycles — its OK + little domes increased a little more in heighth, Edges OK
Think flake would seperate OK —
We now let on stay till 9 pm
This will be 36 layers but think it may clinch
No sign of trezing —
The top Edge simply rounded thick — rounded —

When this solution gets older it will be better of
Copper dont change as of notice a slight Crack near top Edge where it turns around sides + also Edge lifted up slightly showing Hydrogen in it —

The 36 layers up to 9 o'clock last night & taken off by Fred — also the other one put on at 9 pm & taken off at 6 am.

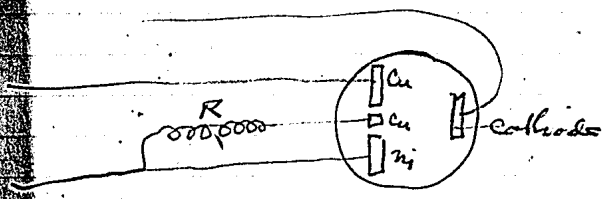
Both had 36 cycles

The all night one had lots trees cupolas not so bad as first one showing that putting the stirrer close to Cathode is an improvement it almost prevents the hills showing that they are largely due to clinging Hydrogen bubbles —

Results, Reciprocating Stirrer Close to Cathode is best way to take care of Hydrogen bubbles the closer the better

2nd That the Rolled Copper anode is not

100 % efficient + that means must be had to keep copper content of solution constant,



I do this by using a small Cu. anode connected to the Ni anode thru a Resistance R

10 ma on Cu for 12 min.
10 ma on small Cu when Ni is only 3 minutes –
will satisfy ~~that~~ an efficiency of only 75 % on Reg or Ream Cu anode

We must find out by Experiment what the Efficiency + Correct it by Extra Cu anode –

Oct 15 1919

Finding that 10 ma dont plate Enough Cu out + to make the ma seconds for Cu + Ni the same as D Bat Co use per inch WE slowed down the plating time to 33 minutes per cycle + 10 ma on Cu 210 ma on Ni + 10 ma on extraordinary Cu anode Connected to the Ni anode thru Resistance,

First cycle showed fine plating both Cu + Ni

Sol 250 cc Conc $NiSO_4$ Purified
6 grms Acetate Sodium may be diff.
6 cc Conc $CuSO_4$
Reciprocating Stirrer 3/32 away from Cathode

20 cycles - full nuts on surface + out lower edge 1/2 doz tests as a whole it is fair + probably 3/4 flake will seperate - Not Enough Copper as Ni plating been too much

I do not have any success in plating out Nickel from a Cyanide of Ni & K with + without a little Cu Cy Kcy. in it —
Unpromising.

180 CC Conc $NiSO_4$
72 grms NaOH
54 " Sodium Citrate
Try plate Nickel
The above plates out Nickel fine — But its not Nickel dissolved in alkali as its neutral — if NaOH added it goes solid A.
This only deposits a blush of Ni in 6 hours NG

A Tartrate Sol which is very alkaline does not plate out any nickel
It underruns the varnish + gas forces it one side
Anode very black, tenaciously adhere, NG

I find that in putting in the annex Copper Anode I didnt allow for the loss of Copper from the bath due to Ni plating — I am now putting 30 ma to the Cu annex instead of 10 + Raising Ni to 230 Ma thus keeping Ni at 200 Ma — This should supply the Extra Cu to bath taken out by Ni plating, its a guess of course —

Nickel Carbonate, reduced at 1000 Fahr by Hydrogen looks dense, preserves original form, on Carbonate Loose powder —

Flake plating

454 250 cc pure $NiSO_4$
6 grms Acetate Magnesia
6 cc Conc pure $CuSO_4$ -

Started to tree at 6 cycles
Removed Cathode 9 cycles
Black & NG.

The 3 tests are doubtful
will make them over again

Acetate Ni
" Mg
" Soda

In addition I will make ~~[illegible]~~
Citrate of Lithia —

Tests made over Flake 2 cycles per hour

10 ma Cu. 230 Ma on Ni but 30 ma of this goes to anneal Cu anode -

456. 250 cc $NiSO_4$ -
6 grms Acetate Soda
6 cc Conc $CuSO_4$

1st Cycle - Copper very poor thin deposit see the Ni in spots Abandoned - it may be its oxidation, NG may want acid

Here is a fine experiment
2 Hours at 200 Ma – 2" ogr
Made 6 Cells. 250 cc $NiSO_4$.
8 grams Acetate Nickel –

1 Cell	no glacial	Acetic
1 "	3 cc	"
1	6 cc	"
1	10 cc	"
1	15 cc	"
1	25 cc	"

As the acidity increased the grain

~~I now doubled the glacial~~
~~The 3 cc was raised to 6 cc~~
~~6 cc " 12~~
~~10 cc " 20~~
~~15 cc " 30~~
~~20 cc " 40~~
~~The 25 cc when no more put in precipitated a lot by diminishing solubility — stirred it up & poured out 1/2 the sol. added water to bring to 25 cc~~
~~30 cc very fine 2 or 3 black spots 40 ~~[illegible]~~ ~~[illegible]~~ finer than 30 cc no black spots Think conc. H_2SO_4 dir. [illegible] not so good as 1/2. that strength as viscosity of strong acid holds bubbles against cathode~~
~~25 with 25 cc — that precipitate [illegible] sight [illegible] the [illegible] [illegible] no [illegible] [illegible] [illegible] amount of acid [illegible] [illegible]~~

of the surface got finer. the surface without any acid was coarse. 5 @ 6 times coarser than 25 cc —

15 cc shows under micro a few black spots, round, seems as if gas bubbles cling 25 cc considerably more black spots. These spots not noticable at a glance

In any event 10 cc is OK

+ possibly 25 cc if solution has a reciprocating stirrer or cathode is a cylinder + rotated high speed. The 25 cc grain is exceedingly fine

Smells strongly of acetic acid
(12) the gas from Cathode -

Incidentally note fine quality of plating
Deposit with only 1/2
strength $NiSO_4$

I used non stripping
Cathode so can't say
if tough will try
this again with
stripping Cathode

Also there was a lot of bubbling
on gas coming off Cathode
& some on Anode - May come
all vanish later - think not

Oct 17 1919

Here is another Experiment

125 cc Conc $NiSO_4$
125 cc Water
4 grams Acetate Nickel
No acetic acid.

Ditto	6	acetic acid glacial
"	10	" I dropped all this adding 6 grms more acetate Nickel only
"	15	" change to that
"	25	" 6 + 10 are finer matte, + is an improvement all round
"	40	"

No acid Even - Strong Matte
6% acetic Even but Coarse matte
10 " finer matte
15 " still more finer matte
25 " Very fine matte
40 Almost smooth but a shade Matte,

The law may be stated that in $NiSO_4$ in presence of Nickel acetate the smoothness of the surface increases with acetic acidity up to 180 cc per liter of solution

The set of Cells 250 cc $NiSO_4$
8 grms Acetate Ni
0 3 6 10 15 25 –
after 1st test had the acetic
acid doubled –
6 12 20 30 – but the
25 doubled to 50 precipitated Salts by
recession of Solubility
I stirred it up & poured
out 1/2 adding water to
bring to 250 cc This cleared
it –

The plating on all got
finer as acid increased,
30 cc showed few black
spots, But the 50 cc acid
diluted 1/2 shows perfect
& fine –

It looks as if $NiSO_4$
should not be conc as
viscosity holds bubbles
on Cathode,

for flake think 200 cc $NiSO_4$
50 cc water 8 grms acetate/L
and 10 cc Acetic acid best

Oct 17 1919

455

250 cc $NiSO_4$ Conc
6 grms Lithia Citrate,
6 cc Conc $CuSO_4$
230 ma on Ni of which 30 goes
to Aluney Copper anode
Concealed to Ni anode
10 ma on Copper
2 Cycles per hour

10 Cycles good - Some spots
no deposits other parts
moundi — No bras + will be
OK flake —
Wants free acid + some
dilution of $NiSO_4$.

It will be seen that this is
very much better than acetate
of Nickel —

Flake 18 Oct 19

457 – 250 cc $MnSO_4$
6 grms Acetate Magnesia
6 cc Conc. $CuSO_4$

Dont plate Copper good
no better than Acetate Soda

Only Citrate Lithia one of
this series is good –

Flake

175 cc $MnSO_4$ 75 Water
5 grms Nickel Acetate
6 cc Conc $CuSO_4$
8 cc glacial Acetic

Dont deposit Copper
good scarcely any
Can see 8/4 +

NG
is it the acid

Oct 20 1919

6 Cells. all ok plating

#1 200 cc $NiSO_4$ 50 cc Water
8 grms Ni Acetate –
Coarse matte, otherwise ok

#2 150 cc $NiSO_4$ 100 cc H_2O
8 grms Ni Acetate
finer matte than #1

#3 100 cc $NiSO_4$ – 150 cc Water
8 grms Ni Acetate
About same as #2

#4 – 75 cc $NiSO_4$ 175 cc aq
8 grms Ni Acetate
same as 3

5 50 cc $NiSO_4$ 200 H_2O
8 Ni Acetate
Quite fine matte

6 – 25 cc $NiSO_4$ 225 Water
8 Ni Acetate
Shade finer Edges show thickening
+ rounding in hills – exp of gas

I now add 10 cc glacial acetic to each cell of the cells recorded on last page having various proportions of coagulator —

#1 fairly fine walled fewer than without acetic acid

2 finer.

3 same

4 same — perhaps little finer

5 about same as 4

6 about same

Not much dif in all except 1st one which is coarser

Here appears a case where increased Viscosity brought warts from gas clinging

6 Cells

125 cc Na SO4 ... H2O

125 cc Water, ... acetic

20 grms Na acetate No acetic

has warts, Coarse matte shows streaks Very Tough.

ditto 6 cc acetic

warts, Coarse matte, streaks not as Tough as #1

ditto 10 cc acetic

warts not so bad fine matte No streaks - Tough

ditto 15 cc acetic

warts just as bad as No 1 No streaks - Edges turned up

ditto 25 cc acetic

not turned up warts same - no streaks

ditto 40 cc acetic

warts -

None of these are good on accounts warts matte -

last 4 are thinner than 1st 5 Warts but no 1 by Excess Na acetate -

Viscosity increased holds bubbles

Resume.

Warts surfaces domes semi circular seem to be due to gas clinging, diminishing viscosity of the solution diminishes the size of warts & when viscosity is low there is none & when very low viscosity matte surface is exceedingly fine grained

460 —

I put up 6 Cells with $CuSO_4$

#1 250 $CuSO_4$

2	drops	6 cc	acetic
3	"	10 cc	acetic
4	"	15	"
5	"	20	"
6	"	25	

All coarse crystals, 4 showed a smut
5 showed considerable smut & bubbles

6 all full of circular holes where bubbles had clung thru whole of plating —

This acts just opposite of Ni Solutions

Added 6 grms acetate Cu to Each
+ Re Run — #1 streaks whole length + badly corroded at streaks —
others OK plating No bubbles in 6
but brown oxide in spots green on 6
green, sandy fine — Improvement but unsatisfactory

Make ucco Test

125 $CuSO_4$
125 Water
1 6 acetate Copper no acid

2 ditto but 6 acetic acid
3 ditto 10 "
4 do 15 "
5 do 20 "
6 do 25 "

perhaps more acid would stop them

All are bright deposits Coarse matte, No 1 has some Cu_2O at Edges.
2 bright - warts at edges
3 " " "
4 " " but literally covered with very deep bubble holes.
5 Worse in holes
6 full holes but not round

Blake

125 $CuSO_4$
125 Water
8 acetate Copper no acid

dito – 6 acetic
" 10 "
" 15 "
" 20 "
" 25 "

With square jar + Copper Cathode, 1500 cc Conc $NiSO_4$ + some acetate Nickel

2 hours 5 amp 48" inches sheet was. 9,780 grammes weight —

The second trial sheet weighed 7.150 grams

Then changed solution Removed 500 cc + put in 500 water + 150 cc Acetic acid Weight of sheet only 3.650 grams

Why

Must make efficiency tests see 2 pages ahead

Cu

125 cc Conc $CuSO_4$
125 cc Water
6 grms Cu Acetate in each cell –

#1 no acid. wants at Edges, blue at Edges, NG

#2 6 grms Citric, good color grain fairly fine, nubs at Edge & between grooves.

#3 10 Citric – less nubs

4 15 Citric about same
5 20 " one Edge discolored "
6 25 "
This has finer grain than any & less nubs –

Nothing promising in this Experiment.

250 cc Conc $CuSO_4$
18 cc Sulphuric

1 Drop Diuvid Dope / Milq in 75 cc
Coarse grain

2 big warts all over

4 very fine grain - warts less

7 grain not so fine Warts all over

12 nubs, warts - not so fine grain
as 7

20 Very long nubs, warts big

Nothing promising in this well
use same Cells + increase the dope
added more dope
25 37 45 60 75 + 100
drops - No improvement
note here that Edges had no
nubs which is curious, warts
+ nubs + filaments bad on
all — Very unpromising

We now run big 6X8 cell with same solution but 1/2 the density 2½ amp for 4 hours instead of 5 amp 2 hours as with all the sheets 1 to 5 taken off

It still gases very much notwithstanding low density

The sheet from 1/2 density only weighed 3.180 grams so low efficiency is not due to H from high density —

May be due to lack of H_2 We are now dissolving More H_2SO_4 in the solution to saturate it again & use 5 amp & 2 hours —

After that will heat sol to get eddy circulation —

20 Baths working in Disc worked at first on Metal OK but after ~~[illegible]~~ 50 digs out crack even on Metal Matrix had to stop — Whereas same solution in the small single bath works OK on both metal & Celluloid taken 37 plating off Spec'd around 1.1 to

Now the only difference we can see is that the small bath is 92 + higher whereas after adding coils around large Tank the Sol in baths are only 78° Fahr We will raise temp to 92 by adding more coils,

Also the filter press cloth & pressure takes out more Ferric hydrox than the little bath does as we use bag of thin cloth + only single head — Ferric hyd May play a part in it.

We just tested Sol 500 cc per inch of plating surface & 800 in small bath 21 [illegible] per inch of [illegible]

in the big bath I find spec G.
1.202 at lab temperature
This seems rather thin I should
for such a large quantity of
Solution, =

This is now most important
Experiment —

I am trying Effect of Fe_2O_3 (hyd)

250 cc Con H_2SO_4
6 grms acetate Ni
6 Acetic
+ Various amounts of
Ferrous Sulphate - this
will oxidize - & bath not being
filtered it will stay in as
colloid —

I find from Mac Mullin that while
the 20 baths are 78° Fahr
The temp of room is
75 - Therefore the heat is entirely
insufficient to meet

Conditions of the small Cell which works at 92 — Mac is having more steam coils put on + also both crocks provided with steam instead of one as now We must have 92 in baths plating —

Oct 25 = Steam coils ~~on~~ around outside of each big crock — They get 92° Fahr in all the baths by circulating heavier from washing face of disc + putting more thru the anode kept They filled the baths with fresh + report first not coming out all right a good The little bath 3 deep keeps working OK This is off from the 20 bath which wouldn't work but bottle + caused us to increase temp to 92 when it is OK

Oct 23 1919

Experts to determine effect of Iron on the New Ni plating sol

2 Hours per 100 ma inch and Temp

250 cc Conc $NiSO_4$
8 grms Nickel Acetate
6 cc glacial acetic
1 grm $FeSO_4$

1 grm - Central part mirror like, around edges matte but exceedingly fine grain

2 grms $FeSO_4$. Mirror like all over, no grain

4 "

6 " all edges brighter than mirror like Heavy, no cracks etc "

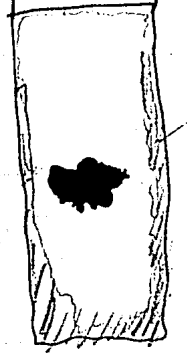
8 " Seems full hair cracks if they are crack "

10 " Seems fuller of Cracks

Repeating with stripping Cathodes + See 2 pages ahead

Note - Considerable reduction to Copper when #2 + 6 put

in Sulphate Copper Conc
after acidifying with H_2SO_4
whole surface of 6 turned
to Copper While No 2 after 1/2
hour was only slightly Coppered
at places



(+) Copper tint

2 gr

Evidently 2 grms $FeSO_4$ can be
used in 250 cc $NiSO_4$ with
acetate & acid a — get polished
surfaces without depositing
more than a slight amount
of iron —

No 5 was entirely
Coppered in 10 mins in
$CuSO_4$ neutralized.
SC

This gives me a new idea for flake
use 200 cc $NiSO_4$ - 50 cc $FeSO_4$ - 8 acetate Ni
10 $CuSO_4$ & some free acetic
deposit Ni 200 Ma on 2"
open circuit for 12 minutes
& let the iron deposited in the
Ni be reduced ~~by Cu~~ to Cu -
then plate again -

---

6 Cells - with 1 to 10 grams
Sulphate iron in $NiSO_4$ 250 cc
8 g Ni acetate 6 cc glacial acetic

When used on 8/4 stripping
Cathodes 1 gram $FeSO_4$
to 10 grams all were
horribly cracked & pealed
Even 1 gram very bad &
Cracking & pealing increased
with the decrease of
increase in $FeSO_4$

Shiny means brittleness
& Iron should be
elemental

This may explain why battery 1st starting is not so good as when older — at first there is appreciable amount of iron in solution. This gradually gets deposited with the nickel — finally all is deposited & Ni ceases to be brittle.

Running the 6x8 cell again. 92 Jahr only gave 4.750 + is no improvement by heat, gasing bad.

This runs it down to lack of acetate Ni. The Ni prove the acetate having been taken away by SO_3 due to low effcy of anode there being no more to neutralize the mineral acid, we get poor plating in presence of mineral acid.

We now take same oof neutralize it with $Ni(OH)_2$ + then add. 20 cc glycerol + Run 5 amp Cold —

Oct 23 1919

I have just sent over to Walter Archer some regenerated $Ni(OH)$ from old cell — used glucose + NaOH + it was deep green more green than Reg $Ni(OH)$ had a little flake + some black undissolved $Ni(OH)$ in it but not much say 10% —

Various Conditions Oct 23 1910

This Experiment illustrates how different Conditions affect Results —

100 NiSO4
100 glacial acetic
50 cc Water
6 grams Ni Acetate
Had to add 150 cc water to this to redissolve precipitate
Fine grain Matte no warts only good one of the lot.

125 Ni Nitrate,
125 Water
10 gram Sodium Sulphite
All green hydrox no metal
Sulfite didnt reduce the Ni and prevent attacking Ni metal —

125 cc Nickel Nitrate
125 cc water
10 grms Na Sulfite 10 cc
acetic acid
All trees –

125 NiSO4
125 water
10 grams Sodium Sulfite
Mirror all over
hair cracks running inward
from Edges –

125 NiSO4
125 H2O
10 grms Na sulfite –
10 acetic acid
Black trees, horrible –

In plating with 2" sqr Cathode on start there is no gas.
250 cc — This equals 125 cc of Conc $NiSO_4$ – 4 acetate Ni to inch Cathode, 125 to 1 + 4 Nacet

In 48" cell. there is 1500 cc but 48" 48-acet, giving only 31" $NiSO_4$ + 1 Nacet to 1 inch 78 or 92 Fahr no change

In the Single bath in Dura dapat that worked so well there is 45 inches + 60000 cc $NiSO_4$ + 960 grms acetate
Equals 888 cc $NiSO_4$ – 21 Nacet. per inch of surface 92 Fahr

Big 133 gal 20 Catho 900 inches [illegible] grms Ni acetate per inch + of $NiSO_4$ 546 cc To 1 inch
78° Fahr

It looks as if we should always have not less than 500 cc of solution of $NiSO_4$ per inch plated out & also 20 grams acetate Ni allated to above 500 cc for acetate for 1 inch surface at 92 or more Fahr

100 cc Conc $NiSO_4$. Conc and temp. there can be added when continuously shaken 23 cc of glacial acetic acid at which point crystals appear the temp is constant at 22° Cent until the crystals appear when it jumps up 5° Cent or 9° Fahr for 250 cc. the limit of acidulation would be 57 cc of glacial

There is enough $NiSO_4$ in big bath but only 1/2 enough acetate Ni allotted to each much There fore about 20 lbs additional should be put in if all the 20 baths are plating simultaneously $NiOH_2$ must be added to return legend so as to get on 40th Clothes to keep up supply of acetate Ni

250 cc Cu Acetate.
plating OK but Evenly black

ditto 6 acetic acid cc
black edges Middle red
grain fairly fine

ditto 10cc Acetic
streaks up — blue oxidations
sides, Especially Top

ditto 15cc Acetic
Peacock Edges,
Middle streaks + Red Cu

ditto 20cc: streaks
smudged sides not bad
Middle red & cept streaks
OK Cu

25cc Acetic sides OK
generally red Except
streaks which are bright
+ OK —
This is all oxidation —
H at streaks prevents oxidation
Ox, comes from wandering from anode

In the 6X8 jar made up
new sol
1500 cc Conc $NiSO_4$
48 grms acetate Nickel
25 cc free acetic
gassed bad
5 amp 2 hours –
Weight 7.400 –
2nd Dup 6.500.
Not right yet,

First sol was
1500 cc Conc $NiSO_4$
didnt record acetate Ni
or free acid got 9.780 wt
2nd trial 7.150 from same sol.

So in above solution I should
have put more acetate Ni
in as its only 1 acet Ni per
inch –

Make up another +
put in as much as it
will stand + same
acetic 25 cc
(Made)

Efficiency Oct 24 1919

Weighed Anodes & Cathodes

250 cc $NiSO_4$

2 4 6 8 10 12 grms acetate

Ni no free acid — 2 Hours 300 ma

First Trial results

after 1st Trial sol to be dumped with same sol but with reweighed Anodes & Cathodes

6 X 8 Cell.

1500 CC Conc Room Temp
$NiSO_4$ — 25 CC Glacial
Acetic —
Saturated at room temp
with acetate Nickel just
to Crystalizing out point
Took 60 grams —

gasis — 5 amp 2 hours

foil — Weighs 7.440
fine plating —

Holding sol for further
Experiment

Memo

Saturated Sol at 22 C room Temp
$NiSO_4$ —
Specif 1.362

$Ni SO_4$ sol 1 Liter
Contains 493 grms dry
$NiSO_4 + 6 aq$ and
744.2 grams water

Or

1 gal solution contains
4.115 grms $NiSO_4 \times 6 aq$
+ 0.744 gal water

1 Liter is 60% free Water 40%
Crystals $Ni SO_4$ 6 aq

There is 44.2% of water in
the $Ni SO_4 \times 6 aq$

100 cc Saturated has
77.68 grms free & combined aq

Note Some time ago we neutralized all our H_2SO_4 but in late experiments we have not done so & we start off with free H_2SO_4 Hereafter we will neutralize

Regeneration of Flake from old Cells —

Reduced to green by heat + Glucose in presence of NaOH,

The washed + flake separated by screens moving under water up + down

Then put in conical jar having paddles rotating in opposite directions + upward stream water adjusted so single flakes will pass up + overflow, but previously

treated with 2% Solution of H_2SO_4 to decolorize any green that may be between leaves of flake which act to hold them together — ~~the~~ The green is left in Seperator —

Flake Thru	on	Weighed	
8 —	10	.05	Weight of green matter
10	20	3.8	379.2 grams
20	30	13.8	
30	40	8.8	
40	50	2.4	91.5 mold
50	60	2.3	8.5 flake
60	70	1.5	about Covered
70	80	1.7	4 mil. flake 28 grams
80	110	0.5	
110	170	0.4	
		35.2 flake	

2nd Run Weighed Cathodes & Anode
200 ma 2 hours
Sol same

Acetate gms	Loss Anode	gain Cathode
2	406	533
4	231	530
6	247	540
8	125	543
10	48	540
12	76	555
	189	540

3rd Run

2	450	551
4	620	517
6	511	539
8	270	523
10	140	498
12	222	497
	369	511

4th Run

2	369	508
4	408	506
6	336	511
8	253	465
10	208	450
12	166	475
	307	486

Dec 13 Results above

5th Run

Acetate		
2	650	519
4	494	479
6	367	502
8	362	464
10	272	465
12	373	471
	419	483

6th Run

2	508	505
4	474	460
6	426	477
8	388	461
10	362	415
12	299	453
	495	492

7th Run

2	570	503
4	516	457
6	608	460
8	405	435
10	335	420
12	421	444
	476	451

8th Run

2	538	511
4	509	484
6	511	479
8	468	460
10	433	447
12	408	442
	490	470

6 Cells – Loss from Anode & gain on Cathodes weighed
250 cc Conc H_2SO_4
2 gms acetate

First Run

	loss Anode	gain Cathode
2	*404	579
4	92	569
6	148	571
8	65	577
10	28	577
12	43	579
	780	
	130	3452
		590

No free acid –
* old rough anode,

Will run same solutions again each time with new weighed Anodes & Cathodes,

See further on

New flakes from SB

Screening Test –

Thru	8	on	10	1%
"	10	"	20	50%
"	20	"	30	45
"	30	"	40	3
lost				1
				100

Of same bulk Recov'd weighs 6.75
New 5.15

This apparently shows some recovered flakes still stuck together,
The 6.75 was thru 20 on 30

We find thru 10 on 20 is even heavier weighing 8.0 grms for same bulk

Shows clearly some hydrox still holding leaves together
Must reduce more & bread longer with acid + perhaps agitate longer

[125]

the bulk should be even greater for same weight compared to new fleece for the reason its more crumpled up,

6X8 Ni bath.
Calliperes sheets also weights

	Calliper	Weights in grams
1	.0021	9.78
2	.0015	7.15
3	.00057	3.65
4	.00115	3.02
5	.00052	4.49
6	.000225	3.18
7	.0004	4.93
8	.000425	4.75
9	.00162	7.40
10	.00082	6.50
11	.0010	7.44
12	.0009	6.60

Dougherty No 2 Iron by
Carbonate Reduced 1000° 7 hrs
H displaced by CO_2

Only average about 6 grams
per pocket.
Chg 400 ma 15H – dis 750 ma to 1V
5th Run
About .363 – MAH –

Great!

I sent over to S B at Co
about 1/2 oz of fine looking
pea green $Na(OH)_2$ regenerated
from an old cell tube mix
by Glucose NaOH method –
Kept up the reduction till
NaOH was perfectly green

This short tube on
1st Run

	Tube 1	Tube 2
1st	963	1013
2nd	1177	1147
4th		1220
10th	1180	1233
15th hot	1190	1233

6X8 Cell.

1500 cc Conc Ni SO4

80 grms acetate Nickel

No acetic acid used

1st plating

Calliper .0013

No 13

Weight 8.980 grms

5 amp 28 hours

48 inches surface

Fine plating – gases considerable

+ lots froth on top of Cell.

2nd Run

Calliper 0015

Weight. 7.672 grms –

No 14

good plating

See further on for 3rd plate

Doughtery —

2. Samples of Fe_2O_3 by Na_2CO_3 process sent to Silver Lake for reduction by Hydrogen & displacement of H by CO_2

No 1 made thus. $FeSO_4$ added to hot Na_2CO_3 — Na_2CO_3 in solution in excess. Settle, filter, removed as much of liquor as possible by suction & tamping down. Dry. Heat to 400° Fahr. Leach by percolation till free of soluable salts finish washing given in Buchner funnel. Dried

Color red / Very fine great covering power but showed tendency to agglomerate

No 2

Hot saturated Sol $FeSO_4$ added to boiling solution of Na_2CO_3, which Na_2CO_3 is in

slight excess settle, remove supernatant liquor equal to 1/2 original volume. Dry. Formed hard cake, Heated to 400° Fahr, leach by percolation leached more easily than No 1, more granular, & showed less tendency to disintegrate. finished in Brachner furnace, Dried.

Color Brown

fineness about same as No 1 but denser & formed firmer nodules

More like ferrous ferric Oxide than ferric

6th

3rd plating in 6X8 cell
80 ml acetate no acetic

Calliper .001
Weight. 6.910 grms
No 15
good plating

4th plating
Calliper .001
Weight. 6.507
No 16
Has gas holes in it, where bubbles stick — This is 1st one showing holes — good soft plating

5th plating
Calliper .001
Weight 6.120
No 17
some holes, — good soft plating
(80 grms acet ml no acid)

6th plating 80 amperes 7½ min

Calliper .001
Weight 6.332
No 18

some holes - good plating
This plating had two 1/2"
bags filled with Nickel
hydroxide dipping into
Electrolyte nearly full
depth - Note that weight
has increased -

7th plating. No H bags
Calliper .0008
Weight. 6.087
No 19
good plating has some gas holes

8th plating -
Calliper .0011
Weight 6.440
No 20
plating good has some gas holes

We remove the hydrate bags
until morning & put them in again
CMJ

6X8 9th plating
Calliper .0012
Weight 6.526
No 21
good plating soft - Has holes

10th plating Calliper .0011
Weight 6.180 2 bags
No 22 -
good soft - only 3 or 4 gas holes

11th Run
Calliper .001 4 bags
Weight 6.360
No 23
Several gas holes, Thes leaf rolled up showing getting brittle

12 Run
Calliper .0009 to .001
Weight 6.073 4 bags
No 24
not curled, plating OK only 4 gas holes

13th Calliper .0011
Weight 6.395
No 25 -
good plating No gas holes

took out ½ the liquor and neutralized it with $Na(OH)$ wet sent by YVM —
Had to heat to 140° Fahr on Bobalos on hot plate to get quick action probably 150 @ 160° Fahr necessary
Cool to bath temp —

14th Run
Calliper 001275
Weight — 7.857
No 26

fine plating 6 holes but they seem all but one due to holes and defects in the Cathode —

15th Run
Calliper .001
Weight 6.928
No 27

16th Run
Calliper 00112
Weight 6.99 -
No 28

17th Run
Calliper 000925
Weight 6.562
No 29

good plating — no holes
See opposite page

18 Run Calliper 001
Weight 5.891 Several holes
Number 30 OK plating

19th Run 1/2 Electrolyte removed & neutralized
Calliper 002
Weight 7.641
No 31
Voltage 10 min after start 2.8
" 10 before finish 2H 2.6
Temp Room 75°F
" Cell 84°F 10 min before finish
fine plating.

20 Run with series same sol.
Calliper 001 Voltage after 20 Hr 2.6. End run 2.5
Weight 6.345 Temp End run 90° Fahr
Several holes plating OK No 32 Room 75° Fahr

21 Run Calliper 001 Volt Start 2.5 " End 2.5
Temp end run 92°F Weight 6.525
Room 77 No 33 good plating 1 hole

22 run
Calliper 0013
Weight 9.016
Same sol from which 22 sheets taken
Completely neutralized by gum but Weight
1st Run — No 34 from all baths used in this app — See 5 sheets ahead

29 Oct 1919

Melanie
8% + water Cuboy 5 cc
NaOH. heat to 1300° Fahr 5 hours, 5 days in 20% NaOH on butter dish on hot plate blue not great 3 hours before appearing Then soaked in 2 changes of water, dried — Dropped 1 ft 20 times, broke on 1st 3 ft drop

Dup — heat to 1000° Fahr broke on 16th 1 ft drop blue came out about same both appear OK for Comal work —

Note A piece of Nickel plating tarnished by 8/4 — put into acidulated sol of Cuboy — in 4 days was bright 8/4 disappeared —

insert this Note —

All of the Solution removed from bath after 13 runs, 1500 cc 750 cc was heated to 140 + neutralized by qvm $Ni(OH)$ wet + filtered — + put with original 750 which was not neutralized —
Hence the bath now is 1/2 neutral + 1/2 as it was acid,
This reduces acidity as a whole —
Found a metallic sediment from the anode in bottom of jar about 30 mesh also some size apparently + it weighed 27 grams
Evidently all Ni anodes shed these particles
+ Goff should save it notified him — above anode
Shed 25% of that plated out

	Anode	Cath
9th Plating 6 cells weighed		
2	478	475
4	425	453
6	292	464
8	358	450
10	312	442
12	353	465
10th		
2	419	454
4	402	424
6	471	450
8	484	453
10	538	439
12	465	456
11th —		
2	527	436
4	463	425
6	543	410
8	432	395
10	358	401
12	378	418
12th		
2	351	418
4	346	380
6	359	386
8	341	394
10	329	373
12	287	414

	Anode	Cath
13th		
2	497	404
4	430	370
6	446	380
8	387	379
10	343	364
12	353	411
14th		
2	464	419
4	462	385
6	428	370
8	452	355
10	490	360
12	447	401
15th		
2	593	466
4	562	421
6	547	399
8	523	365
10	491	397
12	484	405

See 4 sheets above

Slow 1

CuO Disc

Moulded with 4 $\frac{1}{4}$" holes in stands & 1ft drops as it was in a batch to worked poorly probably from wrong baking 1000° Fah it will go 20 when properly made & baked at 1100 to 1200° Fah & be OK —

This is easily moulded & will be OK

Oct 31 1919

81 amp + 90 amp but split dif called it 85.5
in morning found V had decreased during night from .7 to 0.22

Dischg kept constant at 400 ma.

I soaked out KOH + Zincate when dry it made 6 lb drops,

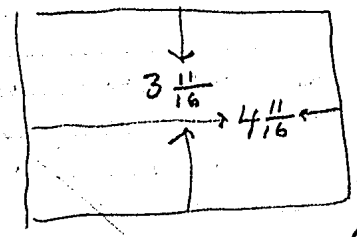
Equivalent to 732 amp hours on 2 CuO plate cells at current density of 2.46 amps for CuO — but the little cell had very much more Zinc

Note the Zinc in little cell was shingled over with ZnOX & 1½" loose sediment in bottom of cell —

Cell had 580 cc of 20% NaOH.

Big Cell uses — 3600 cc = Little Cells 7.2 cc per amp
equivalent 4970 — Little Cell 6.8 cc per amp

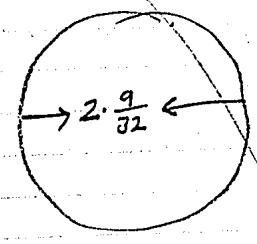
Velavde — 2 CuO plates 500 amp size



25/64 thick

Reg 500 amp 2 cu O cell 4.650 cc

450 cc of 20% NaOH used



13/32 thick

2 large plates have 6.17 times more surface than regular small plate

2 plates have 8.57 times more CuO.

dischg of test cell 101 min max from CuO disc 85.5 amp hours Voltage uniformly .7 over whole dischg didnt catch reading before

Oct 31 1919

I notice that in all Nickel anodes sheet or Cast fine grain Nickel drops to bottom of cell as anode is used up — If a Cup like bottom is originally given to bottom of Anode most of this metallic that would be caught in falling & still being in Contact would be used up instead of falling out of Contact —

Oct 31 1919 Put some floated Potash feldspar into flask with strong NaCl solution on hot plate, The idea is that in time the Na will exchange for K as NaCl take away from Sleanates of K the K + substitute soda — forming KCl — When heating K feldspar with salt at yellow heat there is a complete substitute

Will try Chloride of Calcium also see if Ca will form a lime feldspar + give KCl —

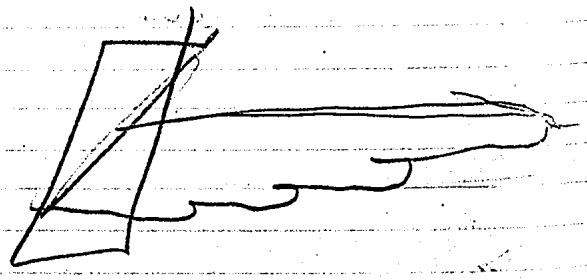
6X8 —

23 run	Calliper	00107	
	Weight	6.480	
	No 35		
24th run	Calliper	.00092	
	Weight	6.475	
	No 36		
25th Run	Calliper	00013	Inside left in a of
	Weight	8.041	all right
	No 37	no holes, specs - 2 left -	
26th Run	Calliper	00122	
	Weight	8.340	
	No 38	no holes good plating	
27 Run	Calliper	0012	
	Wt	8.053	
	No 39	Has several holes otherwise	
28 Run	Calliper	0011	
	Weight	7.550	
	No - 40	a few holes. plating OK	

19th Run Room temp 74°7.
Cell temp 74°7
Voltage

2	2.9 V
4	3.0
6	3.25
8	3.20
10	3.00
12	3.00

Note in other tests
No 12 cell is 2° higher than 2
No 2 has $\frac{1}{10}$th less voltage



16th

2	498	450	20th	2	503	409
4	487	450		4	338	405
6	470	405		6	328	361
8	473	418		8	362	316
10	492	373		10	401	355
12	452	398		12	505	380
17th Run			21	2	448	427
2	597	494		4	450	332
4	524	454		6	508	382
6	553	440		8	443	376
8	475	415		10	384	350
10	433	407		12	368	370
12	461	424				
18th 2	469	483				
4	456	474				
6	423	440				
8	484	434				
10	476	419				
12	430	405				
19						
2	343	394				
4	267	414				
6	340	412				
8	272	418				
10	229	379				
12	271	381				

Running several times without weighing 26th run used 8/4. 2 to 10 ok 12 was little too thick not so thick.
Well now plate many times all on one anode thick no 8/4.
Until 40 plating then well now weighed Cathode + anode.
32th Run on 8/4 stripped ok soft no holes.

PHENOMENON
where my head is shown on cathode the strip 001 is perfectly transparent + would act as a stencil for ambrine dye ink

see 7 sheets further on

Ford pays for Starter Bat
8.63 for one make
8.79 for another make —

Weight of .005 Ni disc of working moulds 61 grams

Now have a CuO disc
8% Benzaldehyde CuSO4 6cc 20% NaOH
baked 1000°F 5 hours
Total active surface 11 inches
2 Zinc sheet strips 1 on
each side 3/4 wide 1/8 thick
dipping in the solution —
2 1/2 inches —
Zinc Surface active 3.9 inches
" " inactive 3.9
7.8
Its voltage stands off OK

I notice that in reducing CuO by Zinc dust + weak H_2SO_4 that the CuO previously soaked in water is not so Copper bright as the dry CuO dust put right into Zinc mush. The 82 amp 1st test was not previously wet so this is probably right way to do it

I think the porosity of the new process $CuSO_4$ bake + 1000 bake is very much greater than old process high temp bake

Tried dehydrating $CuSO_4$ Crystal in boiling Strong oil — NG —

Lecture 9/24/[illegible]

Fred Otto Cell 6x8, 2.5 Volts, 5 amp
2 hours 25 watts 6.5 grams
3.84 Watt hours per gram
1.728 KW Hours per pound
Metallic Ni — Under Worst Condition, by heat + rotation should be less /

I notice that in reducing CuO by Zinc dust + weak H_2SO_4 that the CuO previously soaked in water is not so Copper bright as the dry CuO dust put straight into Zinc mush
The 82 amp 1st test was not previously wet so this is probably right way to do it

I think the porosity of the new process $CuSO_4$ 6 c.c + 1000 bake is very much greater than old process high temp bake

Tried dehydrating $CuSO_4$ Crystal in boiling Strain oil — NG —

Fred Otto Cell 6x8, 2.5 Volts, 5 amp
2 hours 25 watts 6.5 grams
3.84 Watt hours per gram
1.728 KW Hours per pound
Metallic Ni — Under Worst Condition, by heat + rotation should be less /

Jackson
Feb 24

37th Run 2-4-6-8-10-12
with 8/4 all OK & all alike, OK
no holes-

40th Run

2	491	335
4	554	329
6	315	300
8	335	292
10	370	350
12	267	302

45th Run 8/4 - all good plating no holes
soft Ni

50th Run 8/4 all good flat no holes
same thickness - 2 hour
300 ma Cell Voltage 3.1
Cell temp. 86 - Room temp 81

55th Run Volt 3.1 Temp 78°
Room temp 76° - 8/4 plating OK
only ~~8~~ 4 12 one Edge slightly Left -

62nd Run all OK but 12 which
~~stripped which Tore full holes~~
~~but this was brass~~ 3/5

8/4 dont seem to work on Brass

60th Run Weighed

2	476	431	
4	606*	401	* piece anode dried
6	355	377	Volt 3.
8	362	370	Temp Cell 83°
10	417	374	" Room 79
12	361	361	

Nothing but Water has ever been added to these 6 Cells since they started - ?

67th Run with 8/4 Cathode - OK not so flat as usual, few holes in them -

77th Run 8/4 - good plating tough no holes - 2 4 + 6 dead flat 8 10 12 bowed up slightly - but tough - 12 thinnest.

82nd Run OK -

91 Run all perfect no lifts

[ITEMS(S) FOUND IN BOOK]

Sept. 30/19

...ple on Watch glass
from Mr. Edison 9/30/19

Marked :- Residue in Nickel Bath

This from 20 moulds
.005"/" thick scale

This is not a basic Ferric Acetate,
seems to be a mixture of Ferrous
and Ferric Hydrate, 1/3 former
and 2/3 latter, probably
Ferroso-Ferric Hydrate. —
In forming in solution of $NiSO_4$
and Magnesium Acetate, it has
evidently carried out other im-
purities.

Water Soluble :- Consists of $NiSO_4$
entirely, no Fe or Cu Sulphates
Acid Insol. This is probably
3% of the mixture and consists
of sand, nickel scale, some
organic matter that chars by
action of Hot Sulphuric Acid.

See next page

[ITEMS(S) FOUND IN BOOK]

(2)

Soluble (Dilute H_2SO_4)

Ferric Hydrate :- About 2/3 Lime

Ferrous Hydrate :- " 1/3 "

Copper :- present

Manganese :- "

Lead :- none

Bismuth :- "

Arsenic :- faint trace

Antimony :- "

Alumina :- faint trace

Phosphoric Acid :- very faint trace

Carbon Dioxide :- none

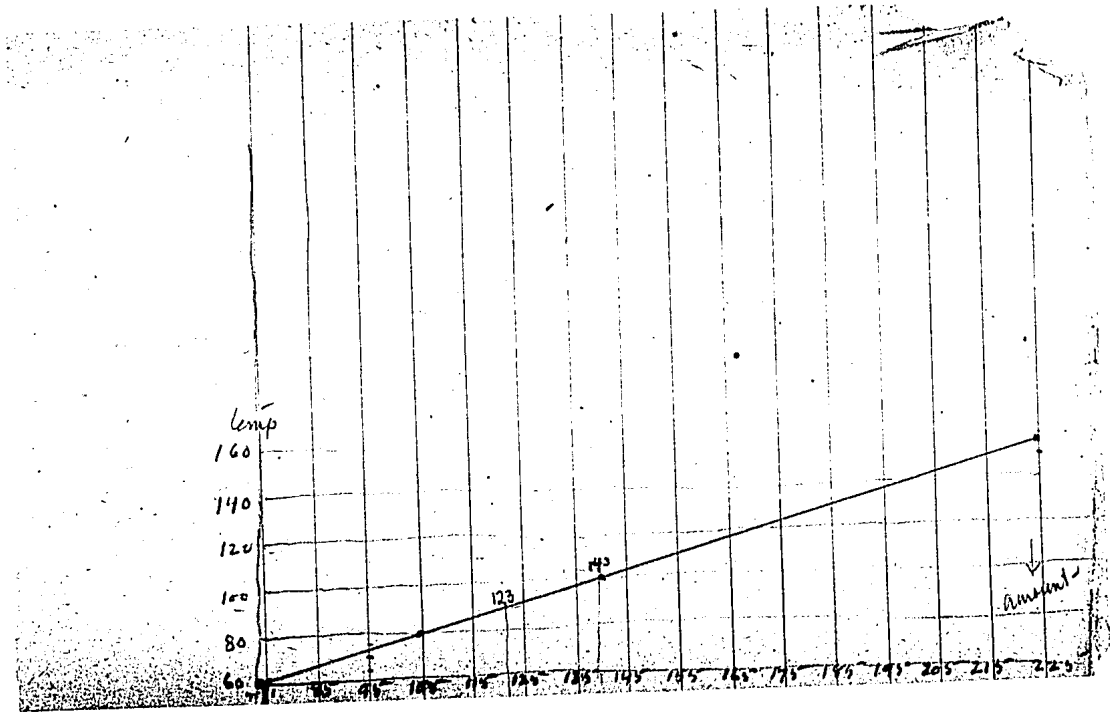
Acetic Acid :- Considerable detect.

Lime :- trace

Magnesia :- " (about 3 times as much as Ca)

E. B. Hughes

[ITEMS(S) FOUND IN BOOK]


temp
160
140
120
100
80
60
123
143
amount